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Reversibility of soil forming clay mineral reactions induced by plant – clay interactions

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Recent data based upon observations of field experiments and laboratory experiments suggest that changes in phyllosilicate mineralogy, as seen by X-ray diffraction analysis, which is induced by plant action can be reversed in relatively short periods of time. Changes from diagenetic or metamorphic mineral structures (illite and chlorite) to those found in soils (mixed layered minerals in the smectite, hydroxy-interlayer mineral and illites) observed in Delaware Bay salt marsh sediments in periods of tens of years and observed under different biologic (mycorhize) actions in coniferous forests in the soil environment can be found to be reversed under other natural conditions. Reversal of this process (chloritisation of smectitic minerals in soils) has been observed in natural situations over a period of just 14 years under sequoia gigantia. Formation of smectite minerals from illite (potassic mica-like minerals) has been observed to occur under intensive agriculture conditions over periods of 80 years or so under intensive zea mais production. Laboratory experiments using rye grass show that this same process can be accomplished to a somewhat lesser extent after one growing season. However experiments using alfalfa for 30 year growing periods show that much of the illite content of a soil can be reconstituted or even increased. Observations on experiments using zea mais under various fertilizer and mycorhize treatments indicate that within a single growing season potassium can be extracted from the clay (illite layers) but at the end of the season the potassium can be restored to the clay structures and more replaced that extracted.

Hence it is clear that the change in clay mineralogy normally considered to be irreversible, illite to smectite or chlorite to smectite observed in soils, is a reversible process where plant systems control the soil chemistry and the soil mineralogy. The changes in clay mineralogy concern mostly the chemical composition of the interlayer ion population of a 2:1 clay structure. However the differences in interlayer ion chemistry give us such mineral names as chloritic hydroxyinterlayered mineral (Mg, OH interlayer), illite (K interlayer), and smectite (essentially hydrated Ca interlayer ions). Extraction of these interlayer ions can be reversed by chemistry engendered by plant regimes.